Twenty-two years of Arctic ozone depletion observations and simulations. Is there a trend ?

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Objectives and Method

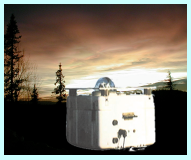
Quantification of chemical total ozone loss inside polar vortex by comparison between modeled passive ozone and measurements

MODELS- 3D CTM
REPROBUS and SLIMCAT
Both models use ECMWF operational analysis 1000 - 0.01 hPa (80 km)
2 runs: a) Passive ozone - initialized on December 1, each winter
REPROBUS from ECMWF ozone operational analysis
SLIMCAT from the output of a long-term simulation
b) Full chemistry

MEASUREMENTS
Total ozone => SAOZ/NDACC UV-Visible network
Twice daily at twilight

UV-Visible SAOZ

- Zenith sky UV-visible spectrometer
- Differential Optical Absorption Spectroscopy
- Ozone: Chappuis bands (450-550 nm)
- Consistency between stations: 3% (NDACC)
- PSC days removed using a color index

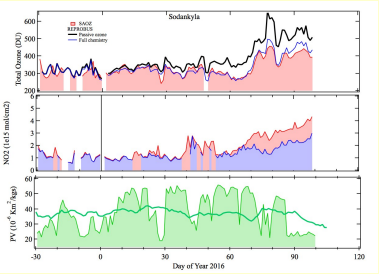


UV-Visible SAOZ network

Winter 2016

1- MEASUREMENTS

Column ozone and NO2 above SAOZ stations



Example: At Sodankyla (Finland)

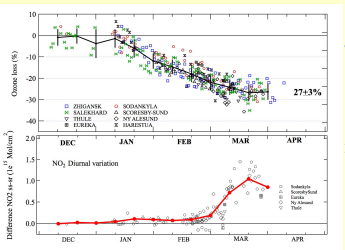
Top:
- Model passive O3 (Black:)
- Model Full chemistry (Blue)
- SAOZ O3 columns (Pink)

Middle:
- SAOZ NO2 at sunrise (blue)
- SAOZ NO2 at sunset (pink)

Bottom
- PV at 475 K from Mimosa contour advection model

2- SAOZ OBSERVATIONS

Ozone loss and denitrification

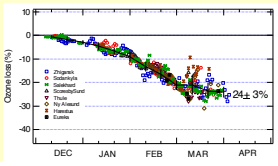


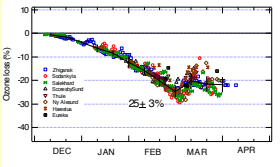
Top
Evolution of ozone loss above SAOZ stations inside vortex
Note the larger loss after March 8 at Ny Alesund.

Bottom
Difference between sunset and sunrise NO2 columns inside vortex

- **Ozone depletion** rate - 0.6% / day between January 10 and February 1
  - 0.4% February 1 and March 10
  - Stopped on March 20
- **NO_2 diurnal increase** (indicating chlorine deactivation) after March 10
- **Total cumulated loss of 27 ± 3%** one of largest Arctic Spring Loss

3- MODEL LOSS ABOVE SAOZ STATIONS



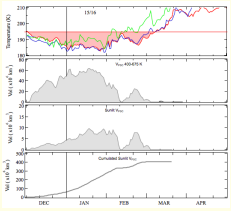


similar results: rate, timing, cumulated loss

REPROBUS
u0.25%/ day from December 20 up to January 30
u0.35%/day from February 1 up to March 1
uStopped on March 1
uLarge scatter after March 1
uCumulated Loss: 24%±3%

SLIMCAT
u0.25%/ day from December 20 up to January 30
u0.4%/day from February 1 up to March 1
uStopped on March 1
uLarge scatter after March 10
uCumulated Loss: 25%±3%

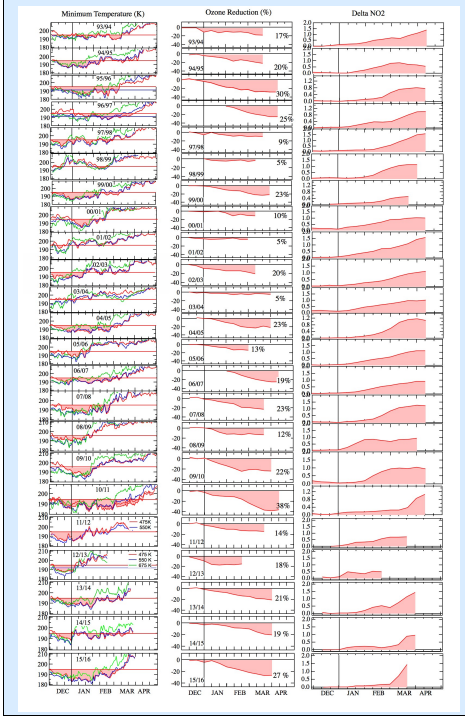
4- METEOROLOGY



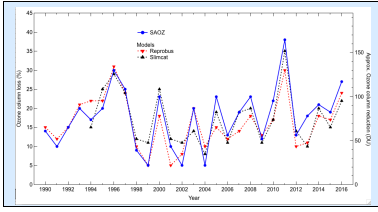
Top
-T<Tnat at levels 475 (red) and 550K (blue) until early March
-T<Tnat athigher level, 675K (green) stopped around February 10

Bottom
- Large sunlit VPSC until March 1st.

Comparison of all winters since 1994

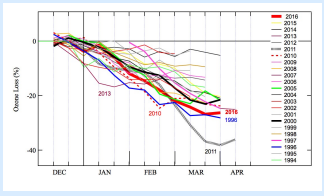


5-OZONE LOSS AND DENITRIFICATION

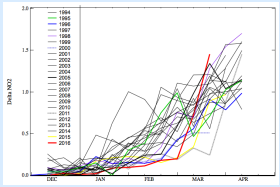


6-SAOZ OZONE LOSS Comparison with REPROBUS and SLIMCAT

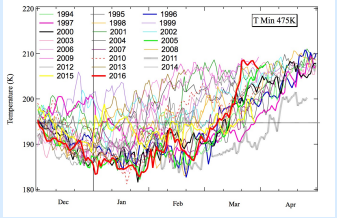
7-OZONE LOSS RATE



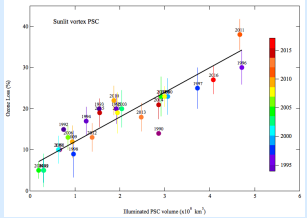
8-DENITRIFICATION



9-METEOROLOGY



10- OZONE LOSS vs SUNLIT PSC



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CONCLUSIONS

- **Large ozone loss interannual variability, dependent on vortex duration**
- **Good agreement between measurements and recent version of CTM models: SLIMCAT and REPROBUS**
- **No indication of ozone loss amplitude reduction**